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(19)(CA) **CANADIAN PATENT** (12)

(54) Tool for Material Surface Modification

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(57) 14 Claims

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ABSTRACT

This invention is a tool for modifying the surface of a material, such as a metal, for the primary purpose of improving adhesive bonding of the prepared material. The tool is a toothed burr-maker which, after application by pressure or impulse to the material to be prepared, leaves a very aggressive surface to which any adhesive will have a mechanical 'key' to bond onto the prepared surface with. The configuration of the tool is easily adapted to provide custom burrs in custom patterns and can be incorporated into a computer-guided operation to prepare selected areas of the workpiece. Self-clamping of the material is also supported through entwining of the opposing burrs. Fiber reinforcement of the bonded joint is also possible.

SPECIFICATIONS

This tool invention refers to an earlier patent application;

Number 579,100-6;

File number 881003;

Division D-2; Class 29; Sub-class 49;

filed on the 3 October 1988, entitled: "Material Surface Modification", hereinafter referred to as BondFace. In that patent application reference is made in Claim 1 to "an apparatus to form burrs". This application for patent protection discloses an embodiment of the said apparatus.

Mechanical material preparation prior to adhesive bonding is presently confined to: sandblasting, wirebrushing, grinding or similar random measures to roughen the surface. The BondFace tool consists of a toothed blade which is made to enter the surface of the material and then move a prescribed and constained amount. The effect is to 'plow' or 'carve' or 'tear' a furrow into the surface to a prescribed depth, and in so doing, create a 'burr' which is in fact the material displaced from the furrow by the carving action of the toothed blade, each of whose teeth simultaneously produce replicas of the burr to the number, depth and spacing provided for by the original blade and tooth configuration. This is accomplished by a relatively simple arrangement of toothed blades, which in one configuration, lie in a stack with every other blade's teeth facing in opposite directions. Thus the carving or plowing of the furrow takes place simultaneously in opposite directions thereby leaving the material being prepared, free from the requirement of clamping or other immobilization techniques. In other words the force transmitted to the material by the quite considerable force required to tear up numerous burrs in a hard material, e.g. metal, simultaneously in one operation, is balanced in both directions thereby cancelling each other and negating material reaction in the form of unwanted movement. Thus this tool can be applied to any area desired (including by computer control), with freedom from the requirements of holding the material save for a backing to resist the applied pressure to the material's face. The tool variables include : the number of teeth, the pitch of the teeth, the cutting angles of each tooth's cutting edge, the number of blades , the overall size of the assembled row of blades and most importantly, the vertical path or depth of penetration and horizontal path or stroke, allowed for in the tool's design which governs the dimensions and characteristics of the burrs produced.

The burrs simultaneously produced by the apparatus described herein, can be engineered as to shape and dimensional characteristics, through the design of the tooth cutting edge. Thus burrs that are, curled or straight or long of thick or fine or intermixed, can be created by BondFace for particular purposes. For example if burrs are required that are to be used for heat embedment in a plastic material, then the blades' teeth can be shaped to optimize burr characteristics for the embedment operation, perhaps with a severe curl to prevent their disengagement under strain of use. Burrs that will allow self-clamping will want to be straight and vertical such that the opposing burrs on the two pieces to be assembled will entwine as the material is brought together with an assembly force sufficient to bend, fold and crush the burrs, thus causing their intermeshing with the result that the two pieces will be immobilized after assembly. Yet another variation might be to raise thick burrs as little as possible so as to allow the capture of a fibrous material, such as glass fibers, which will be clamped between the burr and it's furrow as the burr is closed back under assembly pressure.

The tool has as it's important design features: a method of controlling the depth-path to which the teeth of the tool enter into the material; a means to cause the teeth to carve or plow a path into and across the material, by the blades being displaced away from their starting position; a means of retracting the blades to allow disengagement of the tool from the material after the burrs have been made and to return the blades to the original starting position ready for the next application; and a means of counteracting the vector force parallel to the material's surface generated by the carving or plowing action, with an equal and opposite force being generated by the tool on the material so as to prevent material movement. The overall size of the tool is a function of the area to be prepared. There is no reasonable upper limit as to the number of blades, the number of teeth on the blades, the length of the blades. The tool can also be used in an area adjacent to a burred area so as to enlarge the prepared area, in stages. Using the tool crosswise to earlier prepared areas is also feasible although some burrs will undoubtedly be severed by this action.

In drawings which illustrate embodiments of the invention,

Figure 1 shows an orthographic view of one embodiment of a four-blade pack without the supporting assemblies, showing the cam grooves,

Figure 2 shows the same embodiment where the displacer has displaced the blades horizontally in both directions,

Figure 3 shows one method of controlling the path of depth of penetration into the material,

Figure 4 shows the produced burrs carved into the material in side-section elevation, with burrs of opposing form and only two rows, illustrated,

Figure 5 shows another blade design incorporating a depth control as an integral feature, where the end teeth have been shortened in height,

Figure 6 shows a side view of a two blade assembly with the depth control arrangement detailed in Figure 5,
Figure 7 shows a side view of the same embodiment, where the teeth have penetrated to the depth allowed, and the vector force diagram of the blade movement,
Figure 8 shows how the blades in the pack are maintained in vertical register,
Figure 9 shows a top view of one embodiment where external springs are used to return the blades at a starting position,
Figure 10 shows an end elevation view of the same embodiment of blade pack but with the holder/displacer positioned above,
Figure 11 shows a side elevation of the same embodiment with the holder/displacer and the return spring,

Right Blades 1 have Teeth Facing Right 4 and Left Blade 2 have Teeth Facing Left 5. Cam Grooves 8 on both blade types are offset from each other by an amount determined by the desired burr length and the desired Downwards Vector Force 12 shown in figure 7. Displacer 3 in figure 1 is shown poised above the Cam Grooves. The Displacer fits into a Holder Assembly 20 and 21 in figures 10 and 11. When Displacer 3 is forced into the grooves 8, which may be several in number on a long blade, each with it's own Displacer, a resultant Force Vector 12, provides both a downwards force and a horizontal force which together force all the teeth simultaneously into Material A (figures 6 and 7,) in a prescribed and constrained carving path, comprising a Depth of Cut Path 10, and lateral paths in opposite directions producing Burrs B. Variations of the tooth design produce burrs of the required shape or shapes. In figure 3 a method of controlling the Depth of Cut Path is a Plain Blade 9 which may be several in number and dispersed between the blades of a multiple blade pack. The direction of Blade Movement 6 and 7 indicate that burrs with opposite-direction curl will be simultaneously formed and with counteracting horizontal carving forces applied to the material. Cam Grooves 8 shown in figure 6 indicate their misaligment or offset. This offset is reduced to zero, i.e., alignment, when the Displacer 3 is forced into the Cam Grooves by a vertical force applied to Holder 20-21. Figure 8 shows how the Blades are maintained in vertical alignment by Rollers 15 at each end of the blade pack. The Roller fits into Slot 16 formed in each end of each blade so that all blades will be aligned in the vertical plane and all the teeth are just touching the material. The Roller allows desired lateral independent blade movement but constrains all the blades to a uniform vertical motion into the material thus producing the required Depth 10 for all the burrs to be of thickness 10.

Figure 9 shows a top view of the blade pack with the Rollers 15 and the Extension 18 onto which Return Spring 19 attaches. For clarity the roller is shown unseated in the Slot 16 although in practice the Rollers would be constantly in the slot ends due to Return Spring force. Also for clarity, a Space 17 is depicted between the blades in figures 9 and 10 which may or may not be desirable, but shows the Roller to better advantage and it's relationship to the Slot 16. The Holder 20, 21 is a simple fabricated device with dimensions to engage and stabilize the blade pack between Side Members 20, which also holds the Displacer 3, the whole made rigid by the Cross Piece 21 to which the Side Members 20 are firmly attached.

CLAIMS:

1. A tool for raising a plurality of burrs from a material comprising,
blade means having carving means thereon;
means to advance said blade means into said material and thereby carve a plurality of furrows from which a like plurality of burrs are raised,
means to limit said advance to prevent severing said burrs.

2. A tool for raising a plurality of burrs from the surface portion only of a material comprising,
blade means having carving means thereon, and
advance means to advance said carving means into the surface of said material and thereby carve a plurality of furrows from which a like plurality of burrs are raised,
means to limit said advance means to prevent severing said burrs and to prevent piercing said material.

B

3. A tool as claimed in Claim 1 ~~and~~ or 2 having a plurality of said blade means.

4. A tool for raising a plurality of burrs from a material comprising,
a plurality of blade means having carving means thereon;
said blade means having alignment means thereon and where at least one said blade means is initially misaligned;
means to advance said carving means into said material to:
a. thereby at least partially align said plurality of blade means;
b. thereby carve a plurality of furrows in said material from which a like plurality of burrs are raised;
means to limit said advance to prevent severing said burrs.

5. A tool for raising a plurality of burrs from the surface portion only of a material comprising,
a plurality of blade means having carving means thereon;
said blade means having alignment means thereon and where at least one said blade means is initially misaligned;
means to advance said carving means into said material to:
a. thereby at least partially align said plurality of blade means;
b. thereby carve a plurality of furrows in said material from which a like plurality of burrs are raised;
means to limit said advance and said alignment to prevent severing said burrs and to prevent piercing said material.

6. A tool for raising a plurality of burrs from a material comprising,
a plurality of blade means having operative edge with cutting teeth thereon;
means to hold said blade means in a stack with said operative edge contacting said material;
alignment means on said blade means, at least one said blade initially misaligned with the remainder;
means to advance said operative edges into said material to carve a plurality of furrows from which a like plurality of burrs are raised, and
said means to advance also at least partially aligns said alignment means; and
said means to advance also providing limit to said advance means to prevent severing said burrs.

8. A tool for raising a plurality of burrs from a surface portion only of a material comprising,
a plurality of blade means having operative edge with cutting teeth thereon;
means to hold said blade means in a stack with said operative edge contacting said material;
alignment means on said blade means, at least one said blade initially misaligned with the remainder;
means to advance said operative edges into said material to carve a plurality of furrows from which a like plurality of burrs are raised, and
said means to advance also at least partially aligns said alignment means; and
said means to advance also providing limit to said advance means to prevent severing said burrs and to prevent piercing said material.

A

9. Apparatus for modifying a generally planar surface of a workpiece, comprising at least one chisel member presenting a cutting edge at a planing angle to said surface, structure providing a gauging surface set back from said cutting edge and controlling depth of penetration of the cutting edge into the workpiece during planing movement of the cutting edge of each chisel member relative to the workpiece, structure providing a guide surface directing a cutting planed from the surface of the workpiece into a retroverting curve, and mechanism operable to repeatedly relatively displace each chisel member and the workpiece through a predetermined planing stroke whereby to plane a non-detached cutting of predetermined length from a trough in a first zone of the surface, and operable to withdraw the chisel member from planing engagement with the workpiece, and means for permitting movement of the workpiece relative to the chisel member so that a following planing stroke may be performed on a further zone of the surface spaced from the first zone.

10. Apparatus according to Claim 9, including at least one tool carrying multiple chisel members presenting cutting edges at a planing angle to multiple locations on said surface.

11. Apparatus according to Claim 10, including at least two tools presenting multiple chisel members directed in opposite directions.

12. Apparatus according to Claim 11, including means to simultaneously displace said tools or sets of tools into planing engagement with the workpiece in the direction in which their chisel members are directed.

13. A method of modifying a workpiece presenting a generally planar surface, comprising planing without detachment a plurality of curved, elongated and at least partially retroverted cuttings from spaced, non-overlapping, elongated troughs of approximately constant

depth distributed over said surface, the cuttings remaining continuous with the planar surface at one end of each trough, using at least one tool providing a planing action with a stroke which is small compared with the dimensions of the surface to be treated, whereby to provide the workpiece with a modified surface of increased surface area, part of which increased area is provided by surfaces of the cuttings which face towards and are spaced away from a remainder of the workpiece.

14. A workpiece presenting a generally planar surface with a plurality non-overlapping elongated channels cut in its surface with a non-detached curved, elongated, and at least partly retroverted cutting of said freely machineable material rooted at one end of each channel and springing from it initially in line with the channel and with said surface, the channels and cuttings being short compared with the dimensions of an area of the surface over which the channels are distributed.

Fig 1

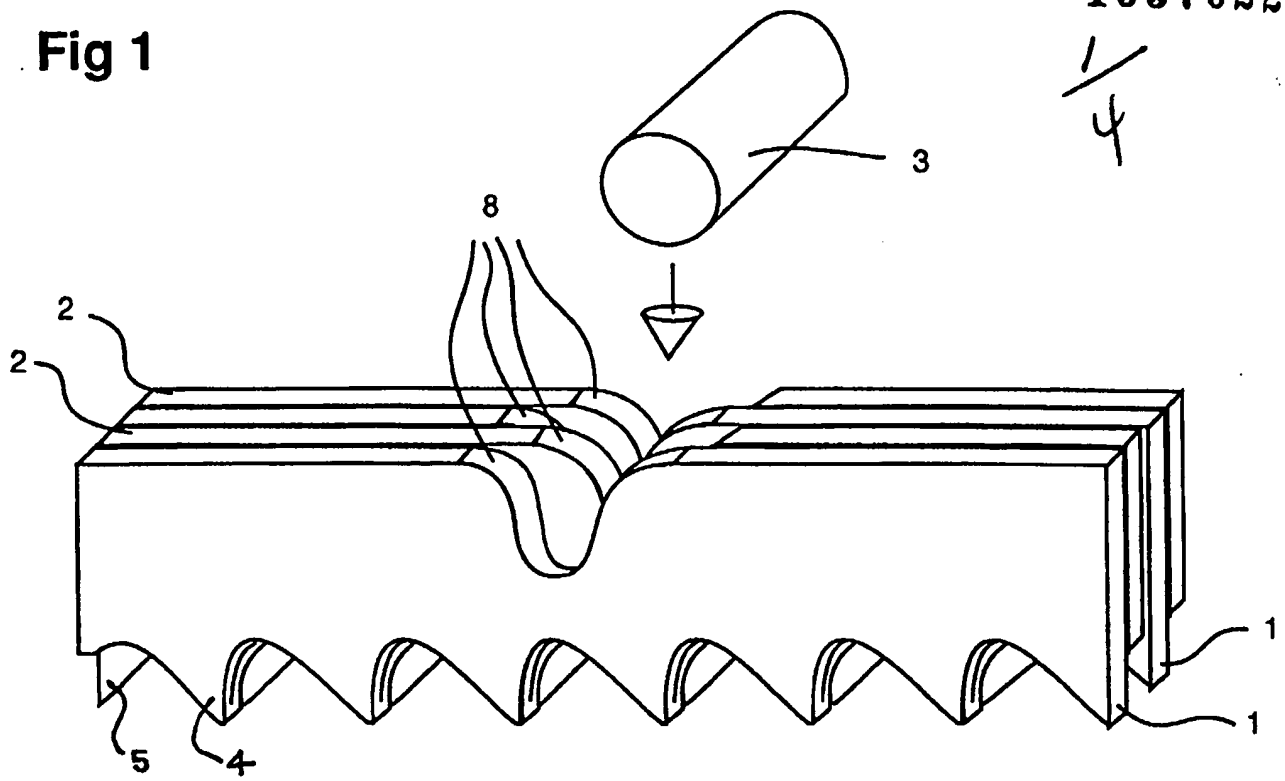

Fig 2

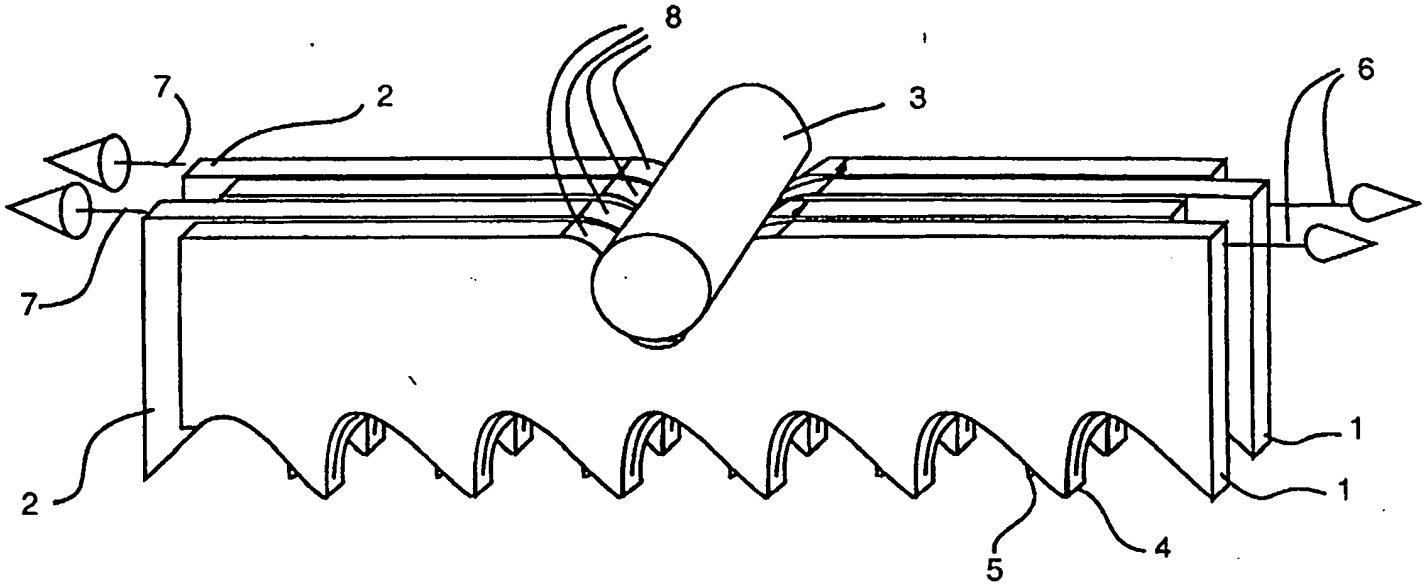

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FIG 3

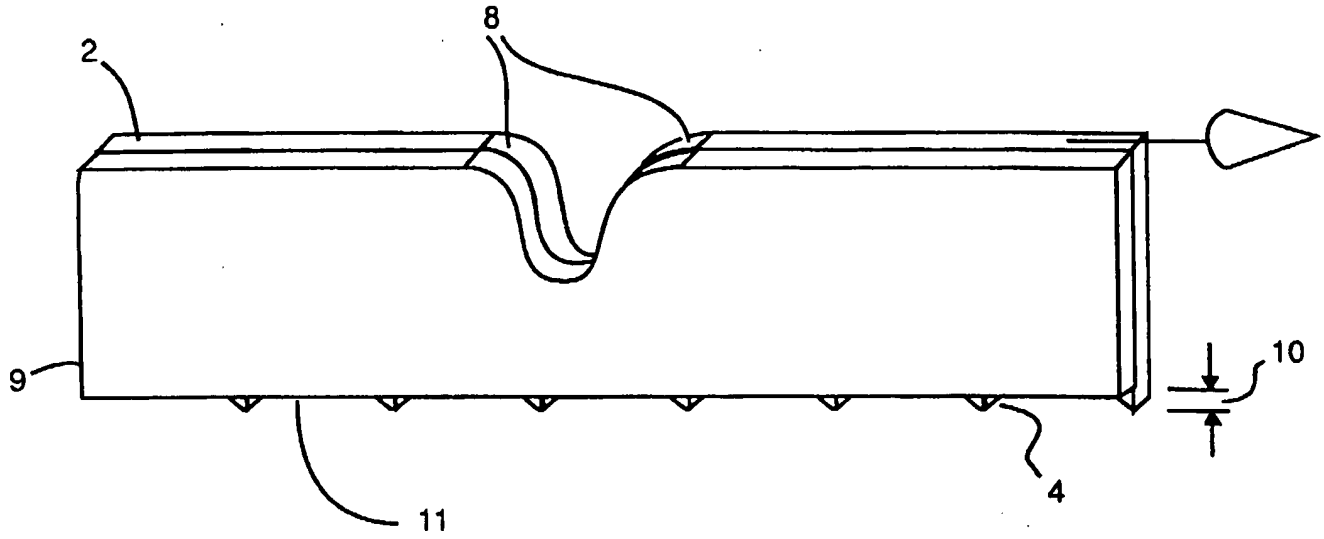

FIG 4

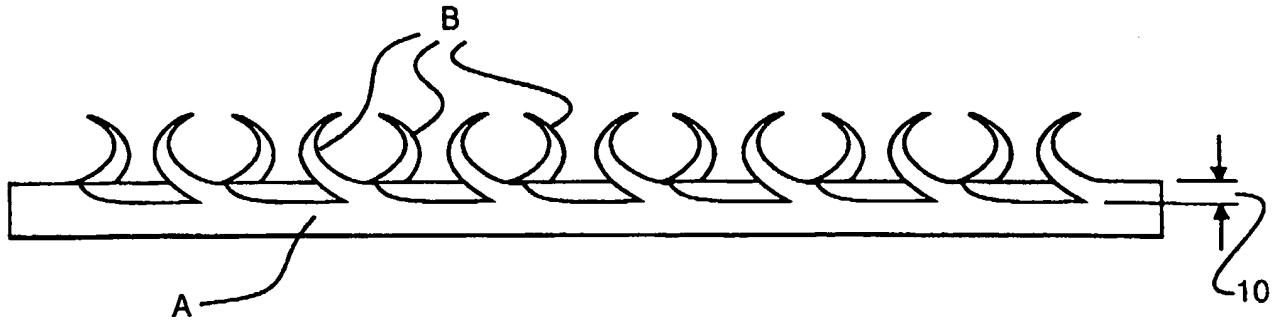

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FIG 5

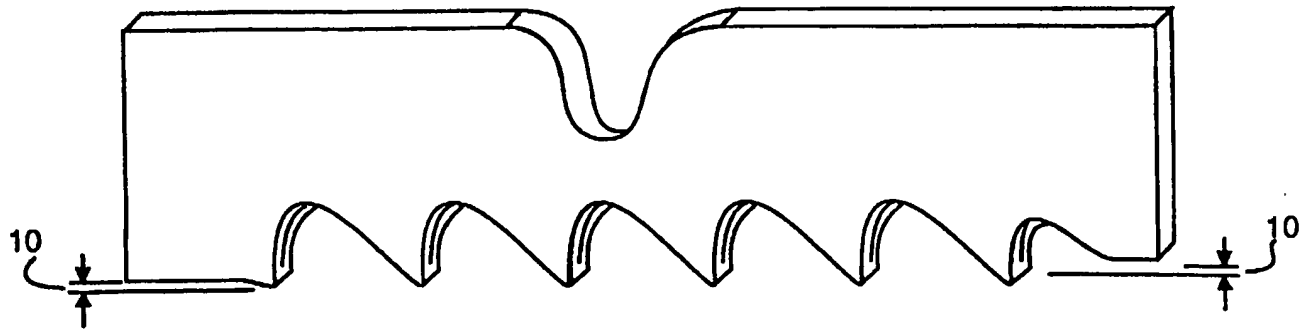

FIG 6

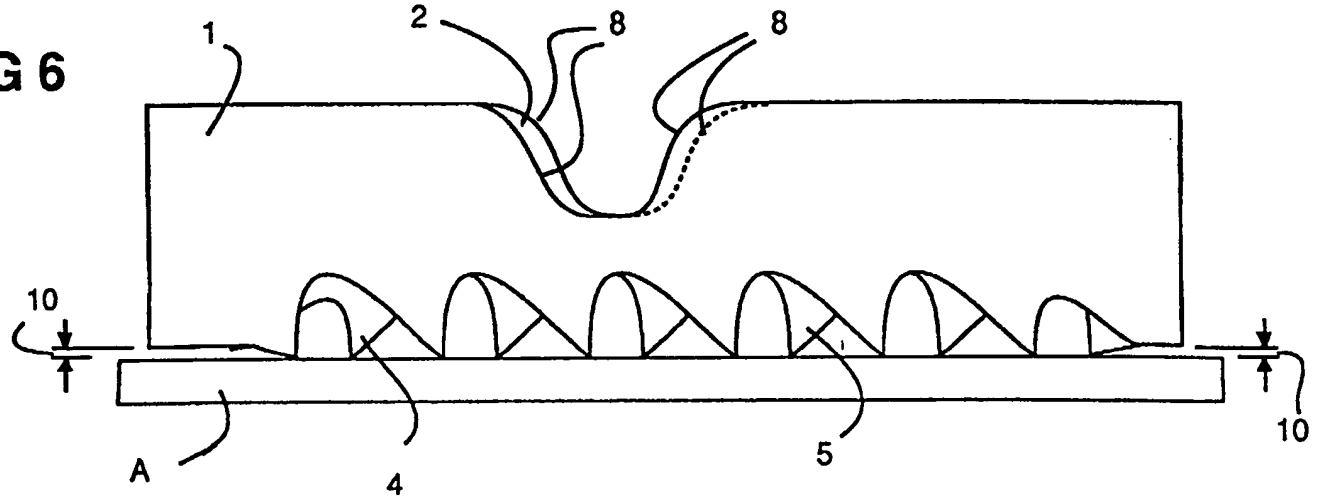

FIG 7

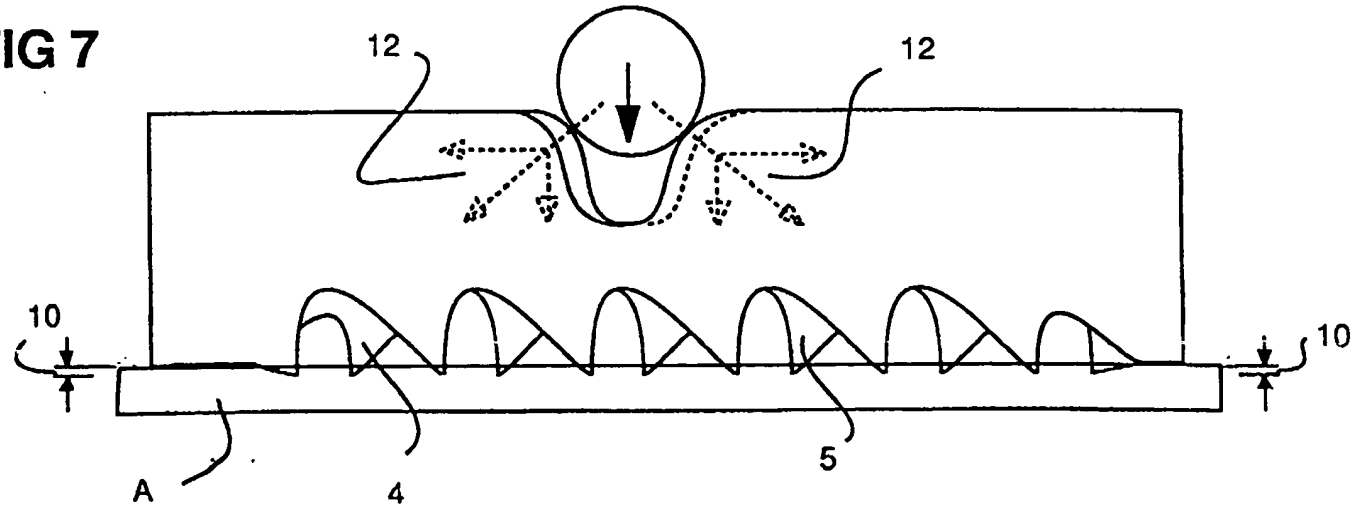

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Fig 8

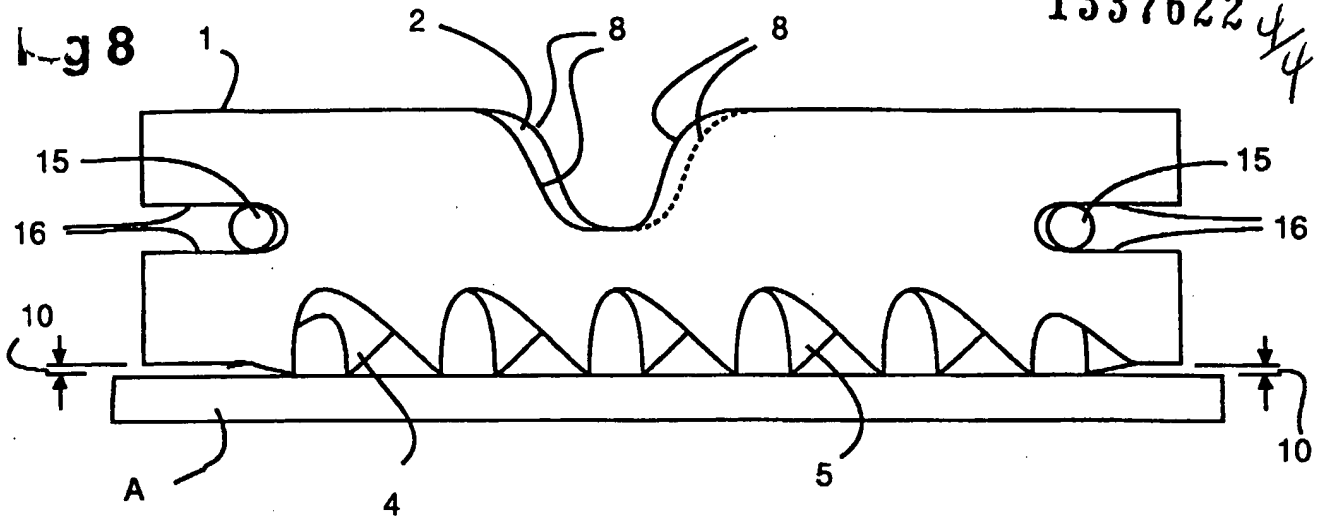


Fig 9

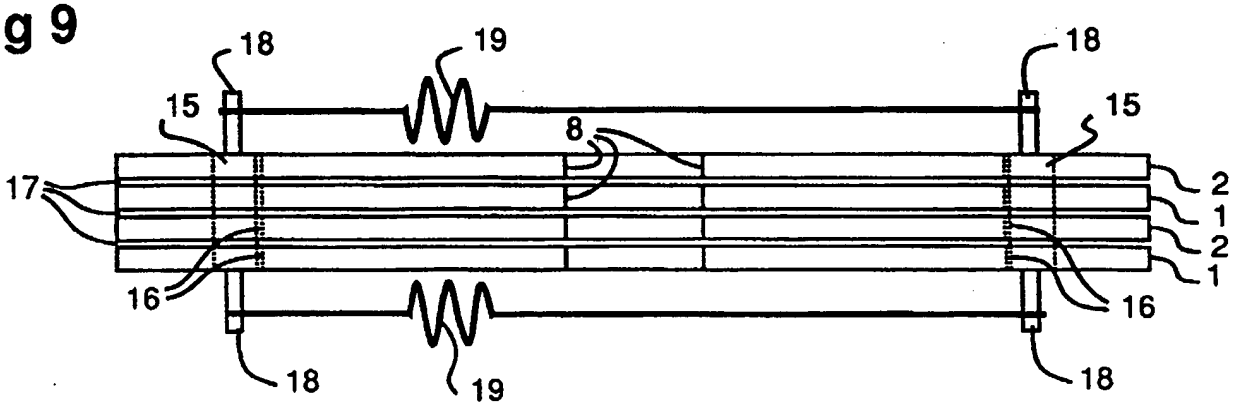


Fig 10

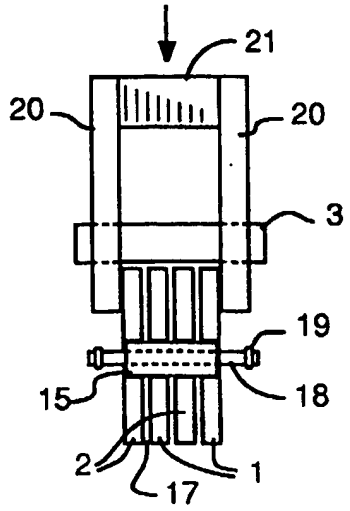
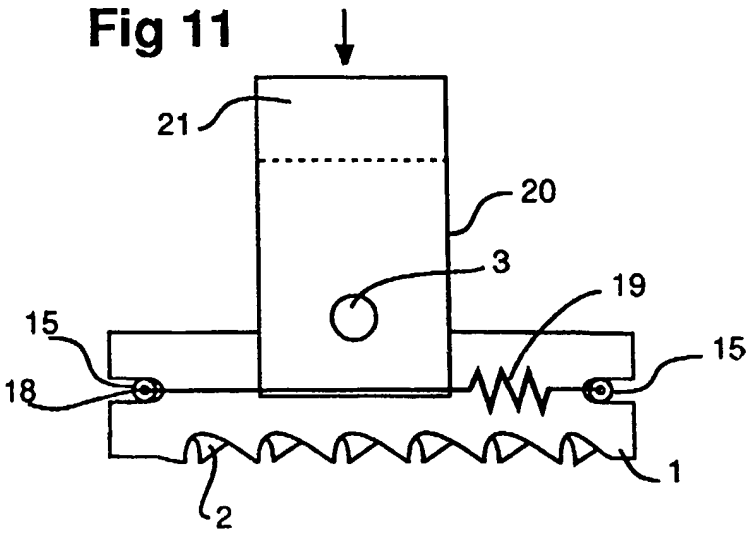


Fig 11



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